seasons the decrease in velocity is greatest in spring. Between 2 and 3 km. the winds decrease in velocity during all seasons, most markedly in summer, and least in spring. The highest velocity, 10.8 m. p. s., occurs in winter at 750 m., and the lowest, excluding the surface winds, is 4 m. p. s. at 4 km.

General comparison.—The winds at Guam have a smaller velocity at the surface than those at Pearl Harbor but from 250 m. up to and including the 4 km. level they are stronger than at Pearl Harbor. From the 5 km. level to the 10 km. level the Pearl Harbor winds are strongest.

ACKNOWLEDGMENTS

Acknowledgments are due to Prof. Charles F. Marvin, Chief of the United States Weather Bureau, for authority to carry out this research; to Prof. A. J. Henry for revision of the manuscript; to Maj. E. H. Bowie, district forecaster in charge of the San Francisco forecast district, for helpful suggestions; to Mr. E. F. Loveridge for aid in locating valuable data; and to Mr. C. E. Cole for assistance in preparing some of the charts. The author also wishes to thank the Governor of Guam for data on surface-wind directions and velocities from that island.

NOTABLE TORNADOES OF MAY, 1927

[Condensed from reports furnished by George Reeder, H. S. Cole, and A. W. Shilling]

Tornadoes of May 8 and 9 in Missouri.[1]—Severe tornadoes occurred in Missouri on both dates. The one of the 8th was first observed in the southwest part of Camden County, moving thence in a northeasterly direction to Audrain County, a distance of 110 miles, where it disappeared.

The May 9 tornado, or as it doubtless will be known in the future, the Poplar Bluff tornado, because it literally demolished the town of that name, entailed a loss of life of 86 persons in Butler County, 83 being killed in Poplar Bluff. Three hundred were injured and the property loss in Poplar Bluff and Butler County is placed at $2,100,000. This storm was first observed in the southwestern part of Randolph County, Ark.; it moved thence to Poplar Bluff, striking that city at 3.15 p. m. In this city, of from 8,000 to 10,000 inhabitants, less than a dozen buildings remained standing, and even these were badly damaged. After leaving Poplar Bluff the force of the storm seems to have been spent, although strong east and northeast winds were observed some 60 miles to the northeast.

Mr. Reeder recites two rather unusual incidents in connection with these storms. The first was that of a well-constructed farmhouse that was bolted to a concrete foundation with half-inch iron bolts. This house was completely wrecked and two persons were killed in the basement by being crushed by great blocks of concrete torn from the foundation. The second incident was the killing of six persons who were caught in a touring car by the storm that overtook Poplar Bluff.

Arkansas.[2]—No tornadoes occurred in this State on the 8th; but an unusually large number, 11, were reported on the 9th. These storms passed through 25 different towns and communities, 71 persons lost their lives, 449 were injured, and the property loss was estimated at $1,223,000.

The geographic position of the tornadoes of the 8th and 9th are shown on regular Chart No. II at the end of this REVIEW, those of the 8th by black crosses and those of the 9th by black dots.

The tornadoes in Arkansas began a little after 2 p. m. in the northwestern part of the State and developed later and later in the day with distance to the eastward; the last storm was first observed at 4:25 p. m. Details as to these storms will be found in the general table on pages 247–250 of this REVIEW.

Nebraska.[3]—On the 8th between 6 and 6:30 a. m. (105th meridian time) a tornado with a path approximately 34 miles long passed across Lincoln County, Nebr., moving in a direction slightly west of north on a line about 5 miles west of the Weather Bureau station at North Platte. No lives were lost in this storm and the damage was confined to farm buildings. The unusual direction of movement of this storm was probably due to the fact that the cyclonic winds in which it originated were moving from the east and southeast.

DISCUSSION

May 8 and 9.—The cyclonic system within which the tornadoes above described occurred was exceptional for the season, particularly because of the low level of the pressure in the center, the track followed by the depression, and its relatively slow progressive movement. See Chart II, track No. IIa.

The pressure gradient over Arkansas and Missouri was not at any time more than fairly steep, nor was it any steeper than that over the adjoining States of Oklahoma, Kansas, and Iowa, in which tornadoes were not reported. Neither was the surface-temperature gradient steep at any time. The 7 o'clock a. m. temperatures over both Missouri and Arkansas on the morning of the 8th were around 70°. There was, however, a steep surface-temperature gradient in the rear of the cyclonic center, especially on the 8th, when the temperature in the cyclone center was 18° to 20° lower than about 200 miles eastward.

The surface wind-shift line on the morning of the 8th was at least 300 miles west of the western border of the State, where tornadoes occurred, and largely because of the northward movement of the cyclone a surface wind-shift line did not pass across either Arkansas or Missouri. The Nebraska tornado occurred in the northeast quadrant and distant about 200 miles from the cyclone center. A pronounced anticyclone was absent on both dates.

In Arkansas the time of occurrence of tornadoes was progressively later and later with distance toward the east. If we can imagine an impulse moving wavelike from west to east, its rate of progression across the State would have been about 25 miles per hour.

The fact that severe tornadoes occurred in Missouri on both dates and in Arkansas only on the 9th is rather puzzling. It might be interpreted as being due to dependence of tornadoes upon conditions of atmospheric instability of more or less local origin which exercises their full influence when, and only when, the presence of a cyclonic system brings about the opportunity of creating an energetic whirl.

The free-air conditions over Arkansas and Missouri may be inferred, approximately at least, by the records of one kite station in Oklahoma and several pilot-balloon stations in neighboring States. These are presented in the

[1] Condensed from a report by George Reeder in Climatological Data for Missouri, May, 1927.
[2] Condensed from a report by H. S. Cole.
[3] Condensed from a report by A. W. Shilling.

following memorandum by Mr. L. T. Samuels of the Aerological Division:

NOTE

Pilot-balloon observations over Missouri and Oklahoma and kite observations over the latter State show decidedly abnormal and significant free-air conditions on the dates when tornadoes occurred in this section, viz, May 8–9, 18, 24, 27. The outstanding features are:

(1) A marked fall in the free-air temperature occurring coincidently with a rise at the surface and lower levels.

(2) The development or intensification of a temperature inversion immediately above the stratum wherein the marked decrease in temperature referred to in (1) occurred.

(3) An abnormally high lapse rate superimposed on the inversion level referred to in (2).

(4) An excessive increase in wind velocity within the first few hundred meters' elevation.

(5) A veering of the wind with height, usually from southerly at the ground to southwesterly at the level of maximum velocity and occasionally veering until a diametrically opposite direction occurs at about 1,500 meters.

WASHINGTON, D. C., TORNADO OF MAY 14, 1927

By L. T. SAMUELS

A tornado, small but distinct and accompanied by a well-marked funnel-shaped cloud, was observed in Washington, D. C., about 6 p. m. on May 14, 1927. At this time the entire western sky was overcast with Cu. Nb. clouds and a thunderstorm seemed imminent. At Fourth and Channing Streets NE. my attention was attracted by a peculiar movement of the clouds in a small portion of the sky toward the northwest. Although no funnel-shaped cloud had yet formed, a rather violent rotary motion was seen at the lower surface of the clouds in this region. The whole cloud mass, including the rotating area, moved moderately fast from the northwest, and portions of cloud in the rotating area soon protruded downward toward the earth and became funnel shaped. A counterclockwise rotation was clearly observed.

While the funnel increased in length small patches of cloud continued to appear and disappear as if by magic out of the comparatively clear air adjacent to and *below* its tip. These puffs of cloud moved rapidly inward or upward (depending on where they formed) toward the main trunk and usually attached themselves onto the latter. When the cloud was 0.7 of a mile south by west of the writer, its lower end appeared to be about 100 feet above the tree tops which formed the horizon. Its actual height above the ground, however, must have been greater, since it was on the opposite side of an intervening ridge. The patches of cloud rising swiftly upward, seemingly out of the tree tops, toward the main trunk presented an exceedingly striking appearance. It was evident that the air was rushing along both inward and upward and that condensation was occurring with a very small vertical displacement.

As the cloud became more and more pronounced and extended to probably between 200 and 300 feet of the ground the surrounding air became densely filled with scraps of paper, branches, dust, etc., which rose within or very close to the cloud itself and then spread out laterally as the top was approached.

The main trunk at the time of its fullest development appeared to be about 50 feet in diameter. By the time it reached a point to the southwest of the observer it had begun to rise and then gradually became absorbed by the main Cu. Nb. layer from which it protruded. The lower extremity, which lashed violently throughout its journey, seemed constantly to fling off patches of cloud from its tip, while new bits formed and took their place.

The length of the path along which the effects of the tornado were greatest was about one-half mile and its width about 30 feet. It extended from First and Adams Streets NW. southeastward across Prospect Hill Cemetery to Rhode Island Avenue and Second Street NE. The damage consisted of a number of good-sized trees being either uprooted or having large limbs torn off, awnings badly twisted, slate shingles torn from roofs, and several tombstones, approximately 4 by 2 by ½ foot blown over.

Practically no wind was noticed on either side of the actual path. The characteristic noise which usually accompanies tornadoes was not heard by the writer, but others closer to its path described the noise as resembling a "siren." Mr. Albert Kiernan, of 49 V Street NW, saw the funnel-shaped cloud as it approached his home from the northwest, and when it appeared to be over the reservoir at the filtration plant he observed what seemed to be a stream of water rising toward the cloud to a height of 200 feet.

A rather heavy shower of short duration occurred in the vicinity shortly after the tornado passed, but only 0.04 of an inch of rain fell at the Weather Bureau 2½ miles to the southwest. The barograph and thermograph records at the latter place showed only the usual fluctuations characteristic of a thunderstorm. This tornado occurred in the southeast quadrant of a low-pressure area. The 3 p. m. pilot-balloon observation at Washington showed a light surface wind from the south-southeast, becoming southwesterly above 500 meters and increasing steadily to 22 m. p. s. at 2,300 meters, where the balloon entered St. Cu. clouds. An unusually large temperature lapse rate was already evident in the morning, when an airplane observation made at the Naval Air Station, Anacostia, D. C., showed this to be 0.80° C. per 100 m. between the 1,500 m. and 2,400 m. levels.

53572—27——2